Part V
Ensuring Long-Term Protection

Chapter 8
Operating The Waste Management System

Contents

Operating the Waste Management System

This chapter will help you:

- *Develop a waste management system that includes procedures for monitoring performance and measuring progress towards environmental goals. The waste management system should identify operational procedures that are necessary to achieve those environmental goals and to make continual improvements in waste management operations.*

Implementing a waste management system that achieves protective environmental operations requires incorporating performance monitoring and measurement of progress towards environmental goals. An effective waste management system can help ensure proper operation of the many interrelated systems on which a unit depends for waste containment, leachate management, and other important functions. If the elements of an overall waste management system are not regularly inspected, maintained, improved, and evaluated for efficiency, even the best-designed unit might not operate efficiently. Implementing an effective waste management system can also reduce long- and short-term costs, protect workers and local communities, and maintain good community relations.

This chapter will address the following questions.

- What is an effective waste management system?
- What maintenance and operational aspects should be developed as part of a waste management system?

I. An Effective Waste Management System

Having an effective waste management system requires an understanding of environmental laws and an understanding of how to comply with these laws. An effective waste management system also requires that procedures be in place to monitor performance and measure progress towards clearly articulated and well understood environmental goals. Lastly, an effective waste management system involves operational procedures that integrate continual improvements in waste management operations to ensure continued compliance with environmental laws. In addition to what is discussed in this chapter, you can consider reviewing and implementing, as appropriate, the draft voluntary standards for good environmental practices developed by the International Standards Organization (ISO). The ISO 14000 series of standards identify management system elements that are intended to lead to improved performance. These include: a method to identify significant environmental aspects; a policy that includes a commitment to regulatory compliance, the prevention of pollution, and continual improvement; environmental objectives and targets for all relevant levels and functions in the organization; procedures to ensure performance, as well as compliance procedures to monitor and measure performance; and a systematic management review process.

The ISO 14000 series of standards include a “specification” standard, ISO 14001. The rest are standards that provide optional guidance for companies developing and implementing management systems and product standards. The ISO 14001 specification standard contains only those requirements that can be objectively audited for certification, registration, and self-declaration purposes. For more information about EPA’s involvement in the ISO 14000 and 14001 standards, refer to the ISO 14000 Resource Directory, October 1997, (U.S. EPA, 1997). Information on obtaining the ISO 14000 series of standards is provided in the text box above. An example of an integrated EMS can be found at **<www.epa.gov/dfe/tools/iems.htm>**.

Additional Information on ISO 14000

The ISO 14000 series of standards are copyrighted and can be obtained by contacting any of the following organizations:

American National Standards Institute (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20026
202 293-8020
<www.ansi.org>

American Society of Testing and Materials (ASTM)
100 Bar Harbor Drive
West Conshohocken, PA 19428-2959
610 832-9585
<www.astm.org>

American Society for Quality Control (ASQC)
611 East Wisconsin Avenue
P.O. Box 3005
Milwaukee, WI 53201
800 248-1946
<www.asqc.org>

NSF International
P.O. Box 130140
789 N. Dixboro Road
Ann Arbor, MI 48113-0140
800 NSF-MARK or 734 769-8010
<www.nsf.org>

II. Maintenance and Operation of Waste Management System Components

All of the time and money invested in planning, designing, and developing a unit will be jeopardized if proper operational procedures are not carried out. Effective operation is important for environmental protection, and for reasons of economy, efficiency, and aesthetics. Operating control systems, therefore, should be developed and maintained by the facility operator to ensure efficient and protective operation of a waste management system. These controls consist of the operator conducting frequent inspections, performing routine maintenance, reporting inspection results, and making necessary improvements to keep the system functioning.

Unit inspections can help identify deterioration of or malfunction in control systems. Surface impoundments should be inspected for evidence of overtopping, sudden drops in liquid levels, ice formation, and deterioration of dikes or other containment devices. Overtopping, or the flowing of waste over the top of the walls of an impoundment, can occur as a result of insufficient freeboard, wind or wave action, or other unusual conditions including the formation and movement of ice within a surface impoundment which can also puncture or tear synthetic liners.

One method of protecting liners from ice damage is to install a liner cover consisting of sand and rip rap along the edge of the liner. Another option is the use of a double liner system. The higher cost of a double liner is offset by reducing the need for rip rap and offers enhanced ground-water protection. Regardless of which method is implemented, liner systems should be inspected for damage and be repaired if necessary after periods of ice formation. Also, make visual inspections periodically to check waste levels, weather conditions, or draining during periods of heavy precipitation. In addition, it is important to consider devising a contingency plan to reinforce dikes when failure is imminent.

Waste piles and landfills should be inspected for adequate surface-water protection systems, leachate seeps, dust suppression methods, and daily covers, where applicable. Land application sites should be inspected for adequate surface-water protection systems and dust suppression methods, as applicable. Inspections of pipes, monitoring of mechanical equipment, and safety, emergency, and security devices will help to ensure that a unit operates in a safe manner. In addition, inspections often prevent small problems from growing into more costly ones.

How should effective inspections be conducted?

To help ensure that routine inspections are performed regularly and consistently, consider developing a written inspection schedule and ensure that staff follow the schedule. The schedule could state the type of inspections to be conducted, the inspection methods to be used, the frequency of the inspections, and a plan of action highlighting preventative measures to address potential problems. Consider conducting additional inspections after extraordinary site-specific circumstances, such as storms or other extreme weather conditions.

Staff conducting the inspections should look for malfunctioning or deteriorating equipment, such as broken sump pumps, leaking fittings, eroding dikes, or corroded pipes or tanks; discharges or leaks from valves or pipes; and operator errors. A written schedule for inspections should be maintained at the facility, and inspections should be recorded in a log containing information such as date of inspection, name of inspector, conditions found, and recommended corrective action. Inspection personnel should be familiar with the inspection log to identify any malfunctions or deficiencies that remain uncorrected from previous inspections.

When designing an inspection form for a unit, add appropriate items for the unit type. You can check with the appropriate state regulatory agency to see if it has an inspection form that can be used. For example, a landfill form would include a section about waste placement and a surface impoundment form might have an entry for sufficient freeboard. If ground water is monitored, you can make ground-water monitoring part of the unit inspection, and add check boxes for each monitoring point to ensure that inspectors collect samples from all monitoring points according to the specified schedule. After an inspection, it is important that all inspection reports are reviewed in a timely manner so that any necessary repairs and improvements can quickly be identified and implemented. You should consult with your state agency to help determine if improvements are necessary.

A. Ground-Water Controls

Ground-water protection controls, such as ground-water monitoring systems, unit covers, leachate collection and removal systems, and leak detection systems should be incorporated into the design and construction of a unit.

Ground-water monitoring wells require continued maintenance. A major reason for maintenance is plugging of the gravel pack or screen. (See Chapter 9–Monitoring Performance for a discussion on the construction of ground-water monitoring wells.) The most common plugging problems are caused by precipitation of calcium or magnesium carbonates and iron compounds. Acid is most commonly used to clean screens clogged with calcium carbonate. In many instances, however, the cost of attempted restoration of a monitoring well can be more than the installation of a new well. Because many wells are installed in unconsolidated sand formations, silt and clay can be pumped through the system and cause it to fail. Silt and sand grains are abrasive and can damage well screens, pumps (if present), flow meters, and other components.

In some cases, the well can fill with sediment and must be cleaned out. The most frequent method of cleaning is to pull the pump from the well, circulate clean water down the well bore through a drop, and flush the sediment out. If large amounts of sediments are expected to enter a monitoring well, consider incorporating a sediment sump (also called a silt trap or sediment trap) into the monitoring well construction. The sump consists of a blank section of pipe placed below the base of the screen. Its purpose is to provide a catch-trap for fine sand and silt which bypasses the filter pack and screen and settles out within the well. This sediment collects within the sump rather than within the screen, and therefore, does not reduce the functional screened length of the well and minimizes the need for periodic cleanouts of the screen. Regardless of the type of ground-water monitoring well installed, the well should be protected with a cap or plug at the upper end to prevent condensation, rust, and dirt from entering into the manhole or protective casing. In addition, it is important to inspect the outer portion of the wells to ensure that they have not been damaged by trucks or other unit operations, and to ensure that the cap or plug is intact.

You also should inspect and maintain unit covers to ensure that they are intact. For optimal performance, covers should be designed to minimize permeability, surface ponding, and the erosion of cover material. The cover should also prevent the buildup of liquids within the unit. Consult Chapter 11–Performing Closure and Post-Closure Care for a more detailed discussion on maintaining cover systems.

It is essential that all components of a leachate collection and removal system and a leak detection system be maintained properly. The main components include the leachate collection pipes, manholes, leachate collection tanks and accessories, and pumps. You should consider cleaning the leachate pipes once a year to remove any organic growth and visually inspecting the manholes, tanks, and pumps once a year as leachate can corrode metallic parts. Annual inspections and necessary repairs will prevent many future emergency problems such as leachate overflow from the tank due to pump failure. Maintain a record of all repair activities as necessary to assess (or claim) long-term warranties on pumps and other equipment.

In surface impoundments, monitor waste liquid levels. An unexpected decrease in liquid levels can be an indication of a release from the impoundment. If a surface impoundment fails, it is important to discontinue adding waste to the impoundment and contain any discharge that has occurred or is occurring. Repair leaks as soon as possible. If leaks cannot be stopped, empty the impoundment if possible. If the size of the unit or amount of waste present prohibits emptying, see Chapter 9–Monitoring Performance and consult with state officials about beginning an assessment monitoring program. Clean up any released waste (see Chapter 10–Taking Corrective Action) and notify the appropriate state authorities of the failure and the remedial actions taken.

B. Surface-Water Controls

If a unit has a point source discharge, the unit must have a National Pollutant Discharge Elimination System (NPDES) permit (or equivalent) and, in some states, might require a state discharge permit. Point source discharges include the release of leachate from a leachate collection or onsite treatment system into surface waters, disposal of industrial waste into surface waters, or release of surface-water runoff (e.g., storm water) that is directed by a runoff control system into surface waters. Even if there are no point source discharges, surface-water controls might be necessary to prevent pollutants from being discharged or leached into surface waters, such as lakes and rivers. If a facility is discharging wastewater to a local publicly owned treatment works (POTW), check with the POTW and local regulatory authorities to determine whether pretreatment standards exist for the facility.

Soil erosion and sedimentation controls, such as ditches, berms, dikes, drains, and silt fences, should be incorporated into the design and construction of a unit. Berms or dikes are often constructed from earthen materials, concrete, or other materials designed to be safely traversed during inspection or monitoring activities. Vegetation also is often used for erosion control. Trees or other deep rooted vegetation, however, should not be used near liners or other structures that could be damaged by roots. Grass is often used for soil stabilization around surface impoundments. For a more detailed discussion of storm-water issues, consult Chapter 6–Protecting Surface Water.

Most if not all of these surface-water controls should be inspected by the operator regularly, especially after large storm events. Structures should be maintained as installed and any structural damage should be repaired as soon as possible to prevent further damage or erosion. Any trapped sediments should be removed and disposed of properly. Vegetative controls frequently need watering after planting and during periods of intense heat or lack of rain.

C. Air Controls

Gases, including methane, carbon dioxide, and hydrogen, are often produced at waste management units as byproducts of the microbial decomposition of wastes containing organic material. Additionally, volatile organic compounds (VOCs) can be present in the waste, and particulate emissions and dust can be generated during unit operations. It is important to analyze wastes carefully prior to designing a waste management unit to determine what airborne emissions are likely to come from these wastes. If airborne emission controls are needed in the design of a unit, maintenance of these controls should be considered as part of a waste management system. For further information on airborne emission controls, consult Chapter 5–Protecting Air Quality.

Methane is a particular concern at some waste management units. Methane is odorless and can cause fires or explosions that can endanger employees and damage structures both on and off site. Hydrogen gas can also form, and is also explosive, but it readily reacts with carbon or sulfur to form methane or hydrogen sulfide. Hydrogen sulfide can be easily identified by its sulfur or "rotten egg" smell. Methane, if not captured, will either escape to the atmosphere or migrate underground. Underground methane can enter structures, where it can reach explosive concentrations or displace oxygen, creating the danger of asphyxiation. Methane in the soil profile can damage the vegetation on the surface of the landfill or on the land surrounding the landfill, thereby exposing the unit to increased erosion. Finally, methane is a potent "greenhouse" gas that contributes to global warming.

Methane is explosive when present in the ranges of 5 to 15 percent by volume in the air. The 5 percent level is known as the lower explosive limit (LEL) and 15 percent as the upper explosive limit (UEL). At levels above 15 percent by volume, methane will not explode when exposed to a source of ignition. Levels above the UEL remain a concern, however, as methane will burn at these concentrations and can still cause asphyxiation.

In the event that methane gas levels exceed 25 percent of the LEL in facility structures or other closed spaces, initiate safety measures, such as evacuating the site and structures. In such cases, or when the methane level exceeds 25 percent of the LEL in the soil at a monitoring point, implement a remediation plan to decrease gas levels and prevent future buildup of gases.

Gas control systems generally include mechanisms designed to control gas migration and to minimize the venting of gas emissions into the atmosphere. Passive gas control systems use natural pressure and convection mechanisms to remove gas from the waste management unit. Examples of passive gas control system elements include ditches, trenches, vent walls, perforated pipes surrounded by coarse soil, synthetic membranes, and high moisture, fine-grained soil. Active gas control systems use mechanical means to remove gas from the unit. Gas extraction wells are an example of an active gas control system.

Gas monitoring and extraction systems require regular maintenance to operate efficiently. As wastes settle over time, pipes can fail and condensate outlets can become blocked. Extracted gas is saturated, which causes moisture to collect within the pipes. Therefore, the condensate within the pipes must be dealt with, otherwise it will affect the pumping suction pressure. Since the plumbing on the top of the unit is quite involved, develop and adhere to a gas maintenance schedule to ensure the efficient operation of gas systems.

If generated gas is not removed from a unit, uplift pressure can cause bubbles within the unit that displace the cover soil at the surface. Gas bubbles also can decrease the normal stress between the geomembrane and its underlying material leading to slippage of the geomembrane and all overlying materials. This creates high tensile stresses evidenced by folding at the toe of the slope and tension cracks near the top.

III. Operational Aspects of a Waste Management System

This section identifies and briefly discusses some of the important operational aspects of a waste management system, including developing an operating plan, performing waste analyses and inspections, installing daily covers, placing wastes in a unit, removing sludge, considering climate, implementing security and access control measures, providing employee training, addressing nuisance concerns, developing emergency response plans and procedures, and maintaining important records. Consider developing practices to ensure compliance with applicable laws and regulations, to train workers how to handle potential problems, and to ensure that all necessary improvements or changes are made to a waste management system. Proper planning and implementation of these operating practices are important elements in the efficient and protective operation of a unit.

A. Operating Plan

An operating plan should serve as the primary resource document for operating a waste management unit. It should include the technical details necessary for a unit to operate as designed throughout its intended working life. At a landfill, for example, the operating plan should illustrate the chronological sequence for filling the unit, and it should be detailed enough to allow the facility manager to know what to do at any point in the active life of the unit.

An operating plan should include:

- A daily procedures component.
- Lists of current equipment holdings and of future equipment needs.
- Procedures to inspect for inappropriate wastes and to respond when their presence is suspected.
- Procedures for addressing extreme weather conditions.
- Personnel needs and equipment utilization, including backup.
- Procedures to address emergencies, such as medical crises, fires, and spills.
- Quality control standards.
- Record keeping protocols.
- Means of compliance with local, state, and federal regulations.

The daily procedures component of the plan outlines the day-to-day activities necessary to place waste, operate environmental controls, and inspect and maintain the waste management unit in accordance with its design. Daily procedures should be concise enough to be circulated among all employees at the unit and flexible enough to allow for any adjustments necessary to accommodate weather variability, changing waste volume, and other contingencies. You should revise and update daily procedures as needed to ensure the unit's continued safe operation within the parameters of the overall operating plan.

Since a unit will likely operate for several years, it is important that staff periodically review the operating plan to refresh their memories and to ensure long-term conformity with the plan. If modifications to the operating plan are necessary, the changes and the date they were made should be noted within the plan itself. Documented operating procedures can be crucial, especially if questions arise in the future regarding the adequacy of site construction and management.

B. Waste Analysis

To effectively manage waste and ensure proper handling (e.g., preventing the mixing of incompatible wastes, use of incompatible liners or containers), knowledge of the chemical and physical composition of the wastes is imperative. Determining waste characteristics can be done by performing a comprehensive waste analysis or through process knowledge. To ensure that this information remains accurate, it might be necessary to repeat the analysis whenever there is a change in the industrial process generating the waste. For further information, consult Chapter 2–Characterizing Waste.

C. Waste Inspections

The purpose of performing waste inspections is to identify waste that might be inappropriate for the waste management unit, and to prevent problems and accidents before they happen. Hazardous wastes, PCBs, liquids (in landfills and waste piles), and state-designated wastes are prohibited from disposal in units designated solely for industrial nonhazardous waste. Some states have developed more stringent screening requirements that require a spotter to be present at a unit to detect unauthorized wastes and to weigh and record incoming wastes.

As part of a waste management system, screening procedures should be implemented to prevent inappropriate wastes from entering a unit. For units receiving waste exclusively from on site, only limited waste screening might be necessary. For facilities receiving waste from off site, screening procedures typically call for screening waste as it enters a unit. Ideally, all wastes entering a unit should be screened, but this is not always practical or necessary. A decision might be made, therefore, to screen a percentage of incoming waste. It might be practical to use spot inspections, such as checking random loads of waste on a random day each week or every incoming load on one random day each month. Base the frequency of random inspections on the type and quantity of wastes expected to be received, the accuracy and confidence desired, and any state inspection requirements. Inspections need to be performed prior to placement of wastes in a unit.

An effective waste management system relies on accurate knowledge of the waste being handled.

Training employees to recognize inappropriate wastes during routine operations increases the chances that inappropriate waste arriving on non-inspection days will be detected. Some indications of inappropriate wastes are color, texture, or odor different from those of the waste a unit normally receives. Also, laboratory testing can be performed to identify different wastes.

A waste management system should include procedures to address suspected inappropriate waste. The procedures to implement, when inappropriate wastes are found, should include the following:

- Segregate the suspicious wastes.
- Use appropriate personal protective equipment.
- Contact the part of the industrial facility that generated the waste to find out more about it.

- Contact laboratory support to analyze the waste, if required.
- Call the appropriate state, tribal or federal agencies in accordance with the opertaing plan.
- Notify a response agency, if necessary.

Should liquids be restricted from being placed in some units?

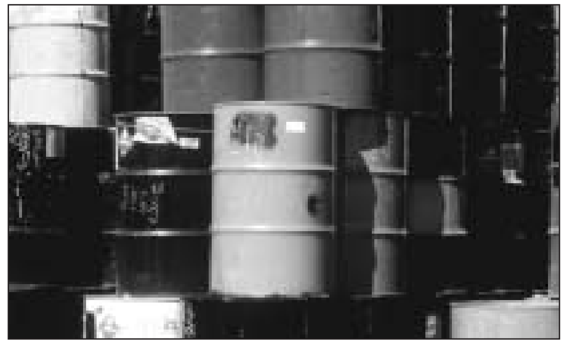
Bulk or containerized liquids should not be placed in landfills or waste piles, as liquids increase the potential for leachate generation. Liquid waste includes any waste material determined to contain free liquids as defined by Method 9095 (also known as the paint filter test) in EPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846). Sludges are a common waste that can contain significant quantities of liquids. You should consider methods such as drying beds to dewater sludges prior to placement in landfills and waste piles.[1]

D. Daily Cover

It might be necessary to apply a daily cover to operating landfills and waste piles. Covering the waste helps control nuisance factors, such as the escape of odors, dust, and airborne emissions, and can control the population of disease vectors where necessary. Some cover materials, due to their ability to hold moisture, can reduce the infiltration of rain water, decreasing the generation of leachate and the potential for surface-water and ground-water contamination.

How is daily cover applied?

Covers most often consist of earthen material, although there are several alternative daily covers being used in the industry today, including coproducts,[2] foam, geotextiles, and plastic sheets or tarps. Examples of coproducts that have been used as daily cover include granular wastes, automobile shredder fluff, foundry sand, dewatered sludges, and synthetic soils. When using coproduct covers that can themselves contain contaminants, ensure that run-on is either diverted before it contacts the cover material or captured and handled appropriately after contacting it. Granular wastes used as daily cover should be low in fine-grained particles to avoid waste being transported by wind. Before using alternative covers, especially coproducts, you should consult the state to determine what, if any, regulations apply.



Inspect waste to ensure that hazardous waste is not placed in a unit.

Daily cover should be applied after the waste has been placed, spread, and compacted. Cover frequency is most often determined by the type of industrial waste disposed of at the landfill or waste pile. Frequent application of earthen material might be required if undesirable conditions persist. A typical daily soil cover thickness is 6 inches, but different thicknesses might be sufficient. When using earthen cover, it is important to avoid soils with high clay content. Clay, due to its low permeability, can block vertical movement of water and channel it horizontally through the landfill or waste pile.

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[1] EPA is investigating the potential of bioreactor landfills as the concept applies to the operation of a municipal landfill. The idea of a bioreactor landfill might be considered appropriate in select cases for an industrial landfill at some time in the future.

[2] In Pennsylvania a coproduct is defined as "materials which are essentially equivalent to and used in place of an intentionally manufactured product or produced raw material and...[which present] no greater risk to the public or the environment."

Using alternative daily cover materials can save valuable space in a waste management unit. Some types of commercially available daily cover materials include foam that usually is sprayed on the working face at the end of the day, and geosynthetic products, such as a tarp or fabric panel that is applied at the end of the working day and removed at the beginning of the following working day. Some of these materials require specially designed application equipment, while others use equipment generally available at most units. Criteria to consider when selecting an alternative daily cover material include availability and suitability of the material, precipitation, chemical compatibility with waste, equipment requirements, and cost.

E. Placing Wastes

To protect the integrity of liner systems, the waste management system should prescribe proper waste placement practices. The primary physical compatibility issue is puncture of the liner by sharp objects in the waste. Ensure that the liner is protected from items angular and sharp enough to puncture it. Similarly, facility employees should be instructed to keep heavy equipment off the liner. Another physical compatibility issue is keeping fine-grained waste materials away from drainage layers that could be clogged by such materials.

Differential settlement of wastes is another problem that can be associated with waste placement. To avoid differential settlement, focus on how the waste is placed on the liner material or on the protective layer above the liner. Uneven placement of waste, or uneven compaction can result in differential settlement of succeeding waste layers or of final cover. Differential settlement, in turn, can lead to ponding and infiltration of water and damage to liners or leachate collection systems. In extreme cases, failure of waste slopes can occur. To avoid these problems, it is important to ensure that waste is properly placed and, if possible, compacted to ensure stability of the final cover.

To protect liner integrity in lined surface impoundments, consider placing an erosion guard or a concrete pad on the liner at the point where waste discharges into the unit. Otherwise, pressure from the waste hitting the liner can accelerate liner deterioration in that area. Inlet pipes can also be arranged so that liquid waste being discharged into the unit is diffused upward or to the side. Although inlet pipes can enter the surface impoundment above the water level, the point of discharge should be submerged to avoid generating odor and disturbing the circulation of stratified ponds. Discharging liquid waste straight into the unit without diffusion is not recommended as this can disrupt the intended treatment.

F. Sludge Removal

If significant amounts of sludge accumulate on the bottom of an impoundment, it might be necessary to remove the sludge and dispose of it periodically. There are two ways to remove the sludge: dewater the cell and remove the sludge after it has dried, or dredge the impoundment. Many different methods exist for dredging an impoundment. Examples include a tanker truck outfitted with a vacuum hose, manned and remote dredges, and submersible pumps on steel pontoons used as a floating dredge or dragged on the pond bottom. You should work with your state and sludge removal professionals to choose or create a method that works best at your facility.

There are two main concerns regarding sludge management: protecting the liner while cleaning out sludge from the impoundment (if a liner is used) and properly disposing of any removed sludge. During dredging, heavy equipment can damage the liner. You can avoid this by selecting equipment and methods that protect the liner during sludge removal. Further, any sludge removed should be evaluated and managed in an appropriate manner, based on its chemical properties.

G. Climate Considerations

Waste management operations can be affected by weather conditions, especially rain, snow, or wind. Rainy or snowy weather can create a variety of problems, such as hindered vehicle access and difficulty in spreading and compacting waste. To combat these difficulties, consider altering drainage patterns, maintaining storm-water controls, maintaining all-weather access roads (if appropriate), or designating a wet-weather disposal area.

Extremely cold conditions can prevent efficient excavation of soil from a borrow pit and can also inhibit the spreading and compaction of soil cover on the waste. Freezing temperatures can also inflict excessive wear on equipment. To combat these problems, you can use coarse-textured soil during winter operations, stockpile cover soil for winter use, and protect cover soil with leaves, plastics, or other insulating materials.

Consider using special inclement weather disposal areas during extreme wet and windy weather. In wet weather, placing waste in a part of the unit near the entrance reduces the likelihood of trucks causing ruts on site roadways or being stranded in mud. Under windy conditions, waste might need to be wetted or placed in downwind areas of a unit to reduce blowing waste or particulates.

H. Security Measures, Access Control, and Traffic Management

To prevent injury to members of the public, consider implementing security and access control measures to block unauthorized entry to a unit. These measures can also help to prevent scavenging, vandalism, and illegal dumping of unauthorized wastes. Providing access controls for the facility within which the unit is located is an example of providing such measures for the unit.

Examples of access control measures include fences, locked gates, security guards, and surveillance systems; and natural barriers such as, berms, trees, hedges, ditches, and embankments. The site perimeter should be clearly marked or fenced. Additionally, consider posting signs that warn of restricted access and alert the public to the potential for harm associated with heavy equipment operations.

How can onsite traffic best be managed?

Even though access to the unit is limited, it is important to provide clear transportation routes for emergency response equipment to access the waste management unit. Traffic management is often overlooked as part of waste management unit operations. Proper traffic routing can help a unit operate more smoothly and prevent injuries and deter intruders. Access roads should be designed and built to be safe and efficient, and blind spots or unmarked intersections should be minimized. They should also be located to provide long-term service without requiring relocation. Posting clear directional signs can help direct traffic and reduce the potential for vehicle accidents. Providing all-weather access roads (if appropriate) and temporary storage areas can improve waste transport to and from a unit and allow equipment to move about more freely. In addition, you can consider imposing onsite speed limits or constructing speed bumps.

Access roads should be maintained properly at all times. Adequate drainage of road beds is essential for proper operation of a unit. Heavy, loaded vehicles traveling to and from a unit deteriorate the roads on which they travel. Equipment without rubber tires should be restricted from the paved stretches of roads as they can damage the roads. Sufficient funds should be allocated up front for the maintenance of access roads.

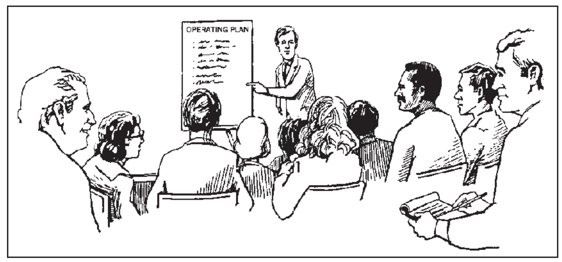
What are some other prudent safety measures?

There are a number of safety considerations associated with ground-water monitoring wells. The tops of monitoring wells should be clearly marked and accessible. In traffic areas, posts and bumper guards around monitoring wells can help protect aboveground installations from damage. Posts and bumper guards come in various sizes and strengths and are typically constructed for high visibility and trimmed with reflective tape or highly visible paint containing reflective material.

Proper labeling of monitoring wells is also important for several reasons. Monitoring wells should be distinguished from underground storage tank fill lines, for example. Also, different monitoring wells should be distinguished from each other. Monitoring wells, therefore, should be labeled on immovable parts of the well.

I. Providing Employee Training

One of the most important aspects of a waste management system is employee training. Employees should be trained before their initial assignment, upon changing assignments, and any time a new health or safety hazard is introduced into the work area. A good training program uses concrete examples to improve and maintain employee skill, safety, and teamwork. Training can be provided by in-house trainers, trade associations, computer programs, or specialized consultants. In some states, proactive safety and training programs are required by law.



Classroom training helps familiarize employees with operating procedures.

What types of training can be provided for employees?

Safety is a primary concern because waste management operations can present a variety of risks to workers. In addition, employee right-to-know laws require employers to provide training and information about safety issues pertinent to a given occupation. Furthermore, accidents can be expensive, with hidden costs often amounting to several times the apparent costs. Accidents at waste management units can include injury from explosions or fire, inhalation of contaminants and dust, asphyxiation from poorly vented leachate collection system manholes or tanks, falls from vehicles, injury associated with operating heavy earth-moving equipment, exposure to extreme cold or heat, and onsite traffic accidents.

To minimize risks to workers, it is recommended that you provide an ongoing safety training program to ensure all staff are properly and regularly trained on safety issues. A safety training program should be consistent with the requirements specified by the U.S. Occupational Safety and Health Administration (OSHA) and include initial training and frequent refresher sessions on at least the following topics:

- Waste management operations.
- Hazardous waste identification.
- Monitoring equipment operations.
- Emergency shut-off procedures.
- Overview of safety, health, and other hazards present at the site.
- Symptoms and signs of overexposure to hazards.
- Proper lifting methods, material handling procedures, equipment operation, and safe driving practices.
- Emergency response topics, such as spill response, fire suppression, hazard analysis, and location and operation of emergency equipment.
- Requirements for personal protective gear, such as hard hats, gloves, goggles, safety shoes, and high-visibility vests.

Weave a common thread of teamwork into every training program. Breaks in communication between site engineers and field operations personnel can occur. Bridging this gap is an important step toward building an effective unit team that can work together. Consider periodic special training to update employees on new equipment and technologies, to improve and broaden their range of job-related skills, and to keep them fresh on the basics. Training can also include such peripheral topics as liability concerns, first aid, avoidance of substance abuse, and stress management.

Sample Manager and Supervisor Training Agenda

- Introduction
- Unit basics:
  —Siting
  —Waste containment
  —Daily operations
- Owning and operating costs
- Machine types
- Equipment maintenance
- Maximizing airspace
- Labor management
- Production analysis
- Application of production rate data
- Budgets and data tracking:
  —Operating budget
  —Cover soil budget
  —Airspace budget
- Waste handling techniques
- Waste management techniques
- Cover soil placement
- Safety issues and safety meetings
- Record keeping
- Emergency response plan
- State requirements for operation

Bolton, N. 1995. *The Handbook of Landfill Operations: a Practical Guide for Landfill Engineers, Owners, and Operators*. (ISBN 0-9646956-0-X). Reprinted by permission.

Equipment Operator Training Agenda

- Introduction
- Unit basics:
  - —Siting
  - —Waste containment
  - —Daily operations
- Heavy equipment types and applications:
  - —Scraper, dozer, and compactor operations
  - —Support equipment
  - —Fluids
  - —Fueling, maintenance and its hazards, and fuel spill prevention
- Cover operations:
  - —Types of cover soil
  - —Placement of cover soil
- Drainage control
- Surveying and staking
- Unit safety:
  - —Emergency response plans
  - —Safe operating techniques
- Owning and operating costs

Bolton, N. 1995. *The Handbook of Landfill Operations: a Practical Guide for Landfill Engineers, Owners, and Operators*. (ISBN 0-9646956-0-X). Reprinted by permission.

How should training programs be conducted?

You should keep records of the type and amount of training provided to employees, and obtain documentation (employee signatures) whenever training is given. Consider establishing regular (at least monthly) safety meetings, during which specific topics can be addressed and employees can voice concerns, ask questions, and present ideas. Keep meetings short and to the point, and steer discussion toward topics that are applicable to those employees present. In addition, do not waste time talking about issues not applicable to a site. If a site experiences extreme weather conditions, develop safety meeting topics that address weather-related safety. Many safety-related videos are available and can add variety to meetings.

Closely monitor worker accident and injury reports to try to identify conditions that warrant corrective or preventive measures. In addition, it is wise to document all safety meetings. Assistance in establishing a safety program is available from insurance companies with worker's compensation programs, the National Safety Council, safety consultants, and federal and state government safety organizations. The overall cost of an aggressive, preventive safety program is almost certain to be offset by the savings from a decrease in lost work time and injuries.

J. Emergency Response Plan and Procedures

There are three major types of waste management emergencies: accidents, spills, and fires/explosions. A waste management system should include emergency response plans for each of these scenarios that considers not only the waste management unit but also all surrounding facility areas. The plans should be reviewed and revised periodically to keep the procedures fresh in employees' minds and to reflect any changes in such items as the unit operating procedures, facility operations, physical and chemical changes in the wastes, generated volumes, addition or replacement of emergency equipment, and personnel changes. If an emergency does arise, or if hazardous waste is inadvertently disposed of in a unit, notify appropriate agencies, adjacent land owners, and emergency response personnel, if needed. After emergency conditions have been cleared, review the waste management system and revise it, if necessary, to prevent similar mishaps in the future.

A facility might be required to prepare similar emergency response or contingency plans under other regulatory programs [e.g., Spill Prevention Control and Countermeasures and Response Plan requirements (40 CFR Part 112.7(d) and 112.20-21); Risk Management Program regulations (40 CFR Part 68); and HAZWOPER regulations (29 CFR 1910.120)]. EPA encourages facilities to consolidate emergency response plans whenever possible to elimante redundancy and confusion. The National Response Team, chaired by EPA, has prepared its Integrated Contingency Plan Guidance (61 *FR* 28642; June 5, 1996) as a model for integrating such plans.

How should an appropriate emergency response plan be developed?

An emergency response plan should consider the following:

- Description of types of emergencies that would necessitate a response action.
- Names, roles, and duties of primary and alternate emergency coordinators.
- Spill notification procedures.
- Who should be notified.
- Fire department or emergency response telephone number.
- Hospital telephone number.
- Primary and secondary emergency staging areas.
- Location of first aid supplies.
- Designation and training of several first aid administrators.
- Location of and operating procedures for all fire control, spill control, and decontamination equipment.
- Location of hoses, sprinklers, or water spray systems and adequate water supplies.
- Description and listing of emergency response equipment.

Sample Laborer Training Agenda

- Introduction
- Unit basics:
  - —Siting
  - —Waste containment
  - —Daily operations
- Traffic management and safety
- Interacting with the public
- Load segregation and placement
- Hazardous material identification procedure
- Unit equipment types and applications
- Cover operations
- Equipment maintenance
- Unit safety:
  - —Heavy equipment safety
  - —Traffic safety
  - —Personal protective equipment
- Emergency response plans

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- Maintenance and testing log of emergency equipment.
- Plans to familiarize local authorities, local emergency response organizations, and neighbors with the characteristics of the unit and appropriate and inappropriate responses to various emergency situations.
- Information on state emergency response teams, response contractors, and equipment suppliers.
- Properties of the waste being handled at the unit, and types of injuries that could result from fires, explosions, releases, or other mishaps.
- An evacuation plan for unit personnel (if applicable).
- Prominent posting of the above information.

The emergency plan should instruct all employees what to do if an emergency arises, and all employees should be familiar with the plan and their responsibilities under it. In order to ensure that everyone knows what to do in an emergency, EPA recommends conducting periodic drills. These practice responses could be planned ahead of time or they could be unannounced. Either way, the drills are treated as real emergencies and serve to hone the skills of the employees who might have to respond to actual emergencies. The key to responding effectively to an emergency is knowing in advance what to do.

Communication is vital during an emergency and should be an inherent component of any emergency response plan. Two-way radios and bullhorns can prove invaluable in the event of an emergency, and an alarm system can let employees know that an emergency situation is at hand. It is recommended that you designate one or more employees who will not be essential to the emergency response to handle public affairs during a major emergency. These employees should work with the press to ensure that the public receives an accurate account of the emergency.

K. Record Keeping

Record keeping is a vital part of cost-effective, efficient waste management unit operations. Records should be maintained for an appropriate period of time, but it is a good idea to keep a set of core records indefinitely. Some facilities have instituted policies that records are to be maintained for up to 30 years while other facilities maintain records for only 3 years. Some states have record keeping requirements for certain waste management units and associated practices. You should check with state authorities to determine what, if any, record keeping is required by law and to determine how long records should be kept.

Besides being required by some states, records help evaluate and optimize unit performance. Over time, these records can serve as a valuable almanac of activities, as well as a source of cost information to help fine tune future expenditures and operating budgets. Data on waste volume, for example, can allow a prediction of remaining site life, any special equipment that might be needed, and personnel requirements. Furthermore, if a

Keeping accurate records is an essential part of unit operations.

facility is ever involved in litigation, accurate, dated records can be invaluable in establishing a case.

What type of records should be kept?

Operational records that should be maintained include the following, as appropriate:

- Waste analysis results.
- Liner compatibility testing (where a liner system is considered appropriate).
- Waste volume.
- Location of waste placement, including a map.
- Depth of waste below the final cover surface.
- Inventory of daily cover material used and stockpile.
- Frequency of waste application.
- Equipment operation and maintenance statistics.
- Environmental monitoring data and results.
- Inspection reports, including photographs.
- Design documents, including drawings and certifications.
- Cost estimates and other financial data.
- Plans for unit closure and post-closure care.
- Information on financial assurance mechanisms.
- Daily log of activities.
- Calendar of events.

Health and safety records that should be maintained include the following:

- Personal information and work history for each employee, including health information such as illness reports.
- Accident records.
- Work environmental records.
- Occupational safety records, including safety training and safety surveys.

L. Addressing Nuisance Concerns

Minimizing nuisances, such as noise, odor, and disease vectors, is of great importance for the health of personnel working in the industrial facility and of neighbors that live or work near a unit. This section describes many of the nuisance concerns typical of waste management units and offers measures to address them. Measures besides those listed can also be used to achieve the same objective.

How can noises be minimized?

Noise resulting from the operation of heavy equipment can be a concern for waste management units located near residential areas. Noise can also disrupt animal habitats and behavior. In addition, workers' hearing and stress levels can be adversely affected by long-term exposure to noise. At waste management units where noise is a concern, limiting hours of operation can reduce potential problems. Design access routes to minimize the impact of site traffic noise on nearby neighborhoods. Equipment should also be maintained to minimize unnecessary noise, and affected workers should wear ear protection (plugs or muffs). Berms, wind breaks, or other barriers can be erected to help mute sounds. OSHA has established standards for occupational exposure to noise (see 29 CFR §1910.95).

How can odor be minimized?

Increased urbanization has led to industrial facilities being situated in close proximity to residential areas and commercial developments. This has resulted in numerous complaints about odors from industrial waste management units and industrial processes such as poultry processing, slaughtering and rendering, tanning, and manufacture of volatile organics. Some of the major sources of odors are hydrogen sulfide and organic compounds generated by anaerobic decomposition. The latter can include mercaptans, indole, skatole, amines, and fatty acids. Odor might be a concern at a unit, depending on proximity to neighbors and the nature of the wastes being managed. In addition to causing complaints, odors can be a sign of toxic or irritating gases or anaerobic conditions in a unit that could have adverse health effects or environmental impacts. Plan to be proactive in minimizing odors, and establish procedures to respond to citizen complaints about odor problems and to correct the problems.

Odors can be seasonal in nature and, therefore, can often be anticipated. Some odors at landfills, waste piles, and land application units arise either from waste being unloaded or from improperly covered in-place waste. If odor from waste being unloaded becomes a problem, it might be necessary to place these loads in a portion of the unit where they can be immediately covered with soil. At land application units, quick incorporation or injection of waste can help prevent odor. It also might be prudent to establish a system whereby unit personnel are notified when odorous wastes are coming to the unit to allow them to prepare accordingly. Odors from in-place waste can effectively be minimized by maintaining the integrity of cover material over everything but the currently active face. Proper waste compaction also helps to control odors. Consider implementing gas controls if odors are associated with gases generated from a unit.

If odors emanate from surface impoundments, there are several options available for control, including biological and chemical treatment. The type of treatment for an impoundment should be determined on a site-specific basis, taking into account the chemistry of the waste.

Practices to control odor are especially important at land application units. If land application is used, it is important to apply waste at appropriate rates for site conditions, and design and locate waste storage facilities to minimize odor problems. Make it a priority to minimize potential odors by applying wastes as soon as possible after delivery and incorporating wastes into the soil as soon as possible after application. Cleaning trucks, tanks, and other equipment daily (or more frequently, if necessary) can also help reduce odor. Avoid applying waste when soils are wet or frozen or when other soil or slope conditions would cause ponding or poor drainage. Chapter 7 Section C– Designing a Land Application Program presents information concerning an odor management plan for land application facilities.

Other methods of controlling odors include:

- Covering or enclosing the unit.
- Adding chemicals such as chlorine, lime, and ferric chloride to reduce bacterial activity and oxidize many products of anaerobic decomposition.
- Using biofilters.
- Applying a deep soil cover, whose upper layers consist of silty soils or soils containing a large percentage of carbon or humic material.
- Applying a layer of relatively impermeable soil, so as to reduce gas gen-

eration rates by reducing the amount of rainfall water percolating into the waste.

- Restoring landfill surface covers when subsidence and cracks occur.

Choosing a method for controlling odors involves a comprehensive understanding of wastes and how they react under certain circumstances. Consult with state agencies to determine the most effective odor control method for the wastes in question.

In addition to these steps to control odor generation, consider steps to manage those odors that are generated. When designing a waste management unit, consider installing barriers such as walls, berms, embankments, and dense plantings of trees set at right angles to the flow of cold, odorous nighttime air. These measures can help to impede the odor and dilute it through mixture with higher layers of fresh air. Alternatively, consider placing an impermeable fence or wall on top of a berm or embankment, on its downwind side. This will increase odor plume height, and odors will be diluted on the steep downslope side of the barrier as a result of turbulent mixing of air layers as the cold air flows over it. Try to locate such barriers as close to the unit as possible.

Another design suggestion is to plant fast-growing evergreen trees which have good windbreak properties in buffer-zones around a unit. In addition to dispersing odors, dense plantings of evergreen trees will also help to protect the unit itself from strong winds, reducing the possibility of windblown soil erosion.

How can disease vectors be controlled?

Disease vectors are animals or insects, such as rodents, birds, flies, and mosquitos, that can transmit disease to humans. Burrowing animals, such as gophers, moles, and groundhogs, can also damage vital unit structures, such as liners, final cover materials, drainage ditches, and sedimentation ponds. As a result, these animals can create costly problems.

Consider the following methods to control disease vectors:

- Apply adequate daily cover. This simple action is often all that is needed to control many disease vectors.
- Make sure the unit is properly drained, reducing the amount of standing water that acts as a breeding medium for insects.
- As a last resort, or when the application of cover material is impractical, consider using repellents, insecticides, rodenticides, or pest reproductive control. Care must be taken to make sure that pesticides are used only in accordance with specified uses and application methods. Follow the instructions carefully when using these products. Trapping animals might also be considered, but trapping alone rarely eliminates the problem.

If land applying wastes, subsurface injection and prompt incorporation of waste can help control vectors. Both of these methods work by using the soil as a barrier between the waste and the vectors. If a waste storage facility exists, these can attract vectors as well and should not be overlooked in the implementation of vector control. If vector problems arise

Operating the Waste Management System Activity List

- ❑ Develop a waste management system identifying the standard procedures necessary for a unit to operate according to its design throughout the intended working life.
- ❑ Provide proper maintenance and operation of ground-water, surface-water, and air controls.
- ❑ Develop daily procedures to place waste, operate environmental controls, and inspect and maintain the unit.
- ❑ Review at a regular interval, such as annually, whether the waste management system needs to be updated.
- ❑ Develop a waste analysis procedure to ensure an understanding of the physical and chemical composition of the waste to be managed.
- ❑ Develop regular schedules for waste screening and for unit inspections.
- ❑ If daily cover is recommended, select an appropriate daily cover and establish processes for placing and covering waste.
- ❑ Consider how operations can be affected by climate conditions.
- ❑ Implement security measures to prevent unauthorized entry.
- ❑ Provide personnel with proper training.
- ❑ Establish emergency response procedures and familiarize employees with emergency equipment.
- ❑ Develop procedures for maintaining records.
- ❑ Establish nuisance controls to minimize dust, noise, odor, and disease vectors.

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